O 92: Nanostructures at surfaces: Dots, particles, clusters I

Time: Thursday 10:30–13:00 Location: MA 141

Invited Talk O 92.1 Thu 10:30 MA 141

0-D and 1-D heterostructure mediated material properties of 2-D Transition Metal Dichalcogenides — •Alexander Weber-Bargioni — Lawrence Berkeley National Laboratory, Berkeley, Ca, USA

In this presentation we show how individual atomic defects and linear mirror twin boundaries in 2-D MoSe2, identified with super resolution atomic force microscopy, alter the electronic wave function, imaged via Scanning Tunneling Spectroscopic mapping, leading along mirror twin boundaries to charge density waves and solitons.

Hierarchically ordered defects or adsorbents in two dimensional transition metal dichalcogenides (TMDs - MoS2, WS2, MoSe2, etc*) modify the local electronic states in terms of energy and geometry of the electronic wave functions at length scales of individual wave functions, inducing novel functionality. Due to their 2-D nature, 2-D TMDs are an excellent model system to directly access, visualize and determine the effects of defect mediated electronic wave function tuning using high resolution AFM and differential conductance mapping.

We show the rich, localized electronic structure of individual vacancies and atomic replacements creating 0-D heterostructure, and how 1-D defects can undergo quantum phase transitions creating charge density waves and solitons.

O 92.2 Thu 11:00 MA 141

Thin films of hydrogen-terminated silicon nanoparticles on functionalized surfaces — •Domenikos Chryssikos[1], Markus Wiesinger[1], Martin Stutzmann[1], Anna Cattani-Scholz[1], and Rui N. Pereira[1,2] — [1]Walter Schottky Institut and Physik-Department, Technische Universität München, Am Coulombwall 4, 85748 Garching bei München, Germany — [2]Department of Physics and Institute for Nanostructures, Nanomodelling and Nanofabrication, University of Aveiro, 3810-193 Aveiro, Portugal

Electronic devices incorporating thin films of solution-processed crystalline nanoparticles (NPs) of semiconductor materials have been studied intensively in recent years as an alternative to bulk materials. Silicon is advantageous for use in the form of NPs, thanks to its abundance and non-toxicity. However, thin films of silicon NPs (SiNPs) with H-termination, required for efficient charge transport, are difficult to achieve due to NP agglomeration in solution. In this work, we explore the assembling of thin films of H-terminated SiNPs bound to silicon dioxide surfaces functionalized with a monolayer of decyldiphosphonic acid molecules. We expect this method to provide a stable and patternable immobilization of very thin layers of SiNPs. Deposition of SiNPs can be realized via substrate immersion in SiNP colloid, followed by annealing at 140°C. By comparison with control samples, our results indicate the requirement of substrate functionalization and annealing for a stable, sonication-resistant attachment of SiNPs to the substrates. Further, the electrical properties of the obtained SiNP networks are studied by means of bottom-gate field-effect transistors.

O 92.3 Thu 11:15 MA 141

Towards atomic-scale switches based on self-assembled surface magic clusters — •Martin Franz[1], Jan Grosse[1], Tim Amrhein[1], Chiara Panosetti[2], Karsten Reuter[2], and Mario Dähne[1] — [1]Institut für Festkörperphysik, Technische Universität Berlin, D-10623 Berlin, Germany — [2]Department Chemie, Technische Universität München, D-85748 Garching, Germany

Atomic-scale switches represent the ultimate level of device miniaturization. Here, we present the first example of such a switch based on self-assembled magic clusters on surfaces.

Using scanning tunneling microscopy and density functional theory, we find that so-called centered rare earth silicide clusters forming self-assembled on the Si(111)7×7 surface [1,2] show a bistable switching between two mirror symmetric configurations. Thereby, a rather high energy barrier of 1.3 eV between the configurations suppresses a thermally induced flipping even at room temperature. In the presence of a close STM tip, however, the clusters start flipping between the two configurations indicating a tip-induced lowering of the barrier height, leading to the possibility to intentionally switch the clusters from one configuration to the other and back.

This work was supported by the DFG, FOR 1282, projects D and H.

[1] M. Franz, S. Appelfeller, M. Rychetsky, and M. Dähne, Surf. Sci **609**, 215 (2013).
[2] M. Franz, J. Große, R. Kohlhaas, M. Dähne, and Surf. Sci. **637-638**, 149 (2015).

O 92.4 Thu 11:30 MA 141

Directional and Angular Locking in the Stick-Slip Motion of Au Islands on a Natural MoS2 Crystal Surface — •Felix Trillitzsch — Otto-Schott-Institut für Materialforschung, Friedrich-Schiller-Universität Jena

Atomic force microscopy (AFM) nanomanipulation experiments have been performed on triangular Au islands (with typical linear size of 25-80 nm) previously grown on a MoS2 surface in ultra-high vacuum (UHV) conditions. In ambient conditions the islands are found to move along well-defined preferential directions, independently of the angle of attack of the AFM probe. Molecular dynamics simulations prove that these directions corresponds to the principal crystallographic orientations of the substrate. Additionally, the islands almost never rotate during manipulation, except for a slight wobbling motion (with an estimated angular oscillation amplitude well below 1°). This is very different from AFM-based manipulation experiments with lattice-mismatched contact interfaces, where the direction of motion is determined by the geometry of the problem and roto-translational motion is observed. Apart from shedding light on the fundamental mechanisms of friction our results may find important applications in the controlled positioning of metal islands as electrodes for molecular electronics.

O 92.5 Thu 11:45 MA 141

Investigation of core-shell nanoparticles using scanning transmission x-ray microscopy (STXM) — •Anja Hermanns[1], Sufal Swaraj[2], Thomas Heinrich[1], Caterina Minelli[3], Katia Sparnacci[4], and Wolfgang Unger[1] — [1]Bundesanstalt für Materialforschung und -prüfung, 12203 Berlin, Germany — [2]Synchrotron SOLEIL, 91190 Saint-Aubin, France — [3]National Physical Laboratory, Teddington TW11 0LW, United Kingdom — [4]Università del Piemonte Orientale, 15121 Alessandria, Italy

Products containing nanoparticles encounter us in almost all areas of our daily life. In most cases the particles exhibit a core-shell morphology either voluntarily or involuntarily. The properties of the shell determine the interaction of the particles with their environment and, thus, reliable control over these properties means reliable control over the performance of the particles. Beside its chemical composition, the thickness of the shell is a parameter of utmost importance. A scanning transmission x-ray microscopy (STXM) based methodology is presented for determining the dimensions (shell thickness, core and total diameter) of core-shell nanoparticles which exhibit a strong x-ray absorption contrast and a well-defined interface between core and shell material. The authors acknowledge support from the European Metrology Programme for Innovation and Research (EMPIR) as part of the InNanoPart 14IND12 project. The EMPIR initiative is co-funded by the European Unions Horizon 2020 research and innovation programme and by the EMPIR participating states.

O 92.6 Thu 12:00 MA 141

Tailoring gold cluster growth during sputter deposition on polymer surfaces via pressure and bias voltage. — •Matthias Schwartzkopf[1], Oleksandr Polonskyi[2], Alexander Hinz[2], Thomas Strunskus[2], Franziska C. Löhrer[3], Volker Körstgens[3], Franz Faupel[2], Peter Müller-Buschbaum[3], and Stephan V. Roth[1,4] — [1]DESY, 22607 Hamburg — [2]CAU, 24143 Kiel — [3]TUM, 85748 Garching — [4]KTH, 10044 Stockholm

The utilization of sputter deposition stands out as a versatile routine method in industry and science to precisely adjust properties of metal coatings depending on the application requested. In order to obtain full control over the nanostructural evolution at the metal-polymer interface, we employed time-resolved surface sensitive X-ray scattering (GISAXS) during sputter deposition of gold on thin polystyrene films [1,2]. We correlate the evolution of the metallic layer morphology with changes in the key scattering features. We identify the impact of atomic deposition rate, noble gas pressure and bias voltage on the growth regimes. Whereas the deposition rates effects mainly the nucleation and cluster percolation, the gas pressure and bias voltage

influence the degree of order in the cluster assembly. [1] Schwartzkopf et al., ACS Appl. Mater. Interfaces 7, 13547 (2015); [2] Schwartzkopf et al., ACS Appl. Mater. Interfaces 9, 5629 (2017).

O 92.7 Thu 12:15 MA 141

In-situ investigation of metallic nanoparticle growth in a gas aggregation source — •Oleksandr Polonskyi, Alexander Vahl, Jonas Drewes, Alexander Hinz, Thomas Strunskus, and Franz Faupel — Chair for Multicomponent Materials, Faculty of Engineering, Kiel University, Germany

Metallic nanoparticles play an important role in the growing field of nanotechnology due to the unique properties associated with their small dimensions. Recently, so-called gas aggregation nanoparticle sources (GAS) (Haberland type, based on magnetron sputtering) have become very attractive for nanoparticle generation and they provide the ability to deposit various types of NPs with good control over size and size distribution. However, the processes inside the GAS are not fully understood yet, even though the GAS has often been used for generation of metallic clusters and nanoparticles. We report on the investigation of the initial stages of Ag nanoparticle growth in a gas phase by broadband transmission UV-Vis spectroscopy. We demonstrate that due to their strong particle plasmon resonance, small clusters and nanoparticles can be monitored by UV-Vis spectroscopy in-situ during growth and transport. We found that small clusters are already generated in the region close to the magnetron target surface and generally do not change their size much during transport through the gas aggregation chamber. Our measurements indicate that a high concentration of nanoparticles is located near the magnetron and results in strong coupling between neighboring particle plasmon resonances.

O 92.8 Thu 12:30 MA 141

Winkelaufgelöste Photoelektronenspektroskopie an massenselektierten Silberclustern — •Norman Iwe, Franklin Martinez, Josef Tiggesbäumker und Karl-Heinz Meiwes-Broer — Institut für Physik, Universität Rostock, Albert-Einstein-Str. 23-24, 18059 Rostock, Deutschland

Die Photoelektronenspektroskopie ermöglicht die Untersuchung der elektronischen Struktur atomarer Cluster. Zum einen lassen sich aus der Energie der mittels Photoeffekt emittierten Elektronen Rückschlüsse auf deren Bindungsenergien im Cluster ziehen. Zum anderen enthält die Emissionsrichtung der Elektronen Informationen über den Drehimpulscharakter ihres ursprünglichen Bindungszustands.

In diesem Beitrag werden winkelaufgelöste Photoelektronenspektren von massenselektierten Silberclusteranionen vorgestellt und diskutiert. Für das Silber-Trimer experimentell bestimmte Anisotropie-Parameter werden mit Vorhersagen des Jellium-Modells verglichen.

O 92.9 Thu 12:45 MA 141

Single-molecule fluorescence excited by a scanning tunnelling microscope — •Jörg Kröger[1,2], Benjamin Doppagne[2], and Guillaume Schull[2] — [1]Institut für Physik, Technische Universität Ilmenau, D-98693 Ilmenau, Germany — [2]Institut de Physique et Chimie des Matériaux de Strasbourg, F-67034 Strasbourg, France

Ultrathin NaCl films on Ag(111) were used to efficiently decouple the organic electron donor molecule tetraphenyldibenzoperiflanthene ($C_{64}H_{36}$, DBP) from the metal support and to probe the genuine molecular luminescence. Injecting charge from the tip of a low-temperature scanning tunnelling microscope into DBP leads to photon emission with different quantum yields across the molecule reflecting the presence of a single transition dipole moment. Vibrational progression and hot electroluminescence may be inferred from the photon spectra. By placing the tip in the lateral nanometre vicinity of the molecule light emission is remotely controlled. The spectral line shape of the excited $S_1 \longrightarrow S_0$ transition exhibits a Fano profile whose asymmetry varies with the tip-molecule distance. These data reflect the subtle interplay between the injected charge, the molecular exciton and the plasmonic environment. Financial support by the Deutsche Forschungsgemeinschaft through Grant No. KR 2912/12-1 is acknowledged.